An aerial photograph of Santa Monica, California, showing the city's dense residential and commercial areas. The Santa Monica Municipal Airport is the central focus, with its runways and taxiways clearly visible. The surrounding city is a mix of residential neighborhoods with small houses and larger commercial buildings. The airport is situated in a valley, with hills visible in the background. The text is overlaid on a semi-transparent grey box at the top of the image.

**Calendar Year 2018 CNEL Contours
Santa Monica Municipal Airport**

Prepared for
The City of Santa Monica
April 2019

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1.0 OUTLINE OF NOISE ANALYSIS

Year 2018 CNEL contours were developed using the calendar year 2018 operations and noise measurement data for the airport. The methodology used for the year 2018 CNEL contours has been updated to reflect current noise measurement data using the FAA noise model.

This report contains four major sections including this introduction. Section 2 describes the methodology used for this study. Section 3 describes the existing noise in the environs of Santa Monica Municipal Airport including the 2018 CNEL contours. Section 4 presents historical CNEL measurement data for the airport.

2.0 METHODOLOGY

2.1 BACKGROUND

The methods used here for describing the existing noise environment in terms of CNEL rely heavily on noise measurements made by the airport's permanent noise monitoring system and computer noise modeling. The noise environment is commonly depicted in terms of lines of equal noise levels, or noise contours. These noise contours are supplemented here with specific noise data for selected points on the ground. The computer noise model used here is described in the following below.

2.2 COMPUTER MODELING

Noise contour modeling is a very key element of creating noise contours. Generating accurate noise contours is largely dependent on the use of a reliable, validated, and updated noise model. It is imperative that these contours be accurate for the meaningful analysis of airport noise.

Airport noise contours were generated using the INM Version 7.0d. [1] The original INM was released in 1977. This version, INM Version 7.0d, was released for use in May 2013. The INM is a large computer program developed to plot noise contours for airports. The program is provided with standard aircraft noise and performance data for over 100 civilian aircraft types that can be tailored to the characteristics of the airport in question, as well as a database of military aircraft types.

One of the most important factors in generating accurate noise contours is the collection of accurate operational data. The INM program requires the input of the physical and operational characteristics of the airport. Physical characteristics include runway coordinates, airport altitude, and temperature and optional topographical data. Operational characteristics include various types of aircraft data. This includes not only the aircraft types and flight tracks, but also departure and arrival procedures

that are specific to the operations at the airport. Aircraft data needed to generate noise contours include:

- Number of aircraft operations by type
- Types of aircraft
- Day/Evening/Night time distribution by type
- Flight tracks
- Flight track utilization by type
- Flight profiles
- Typical operational procedures
- Average Meteorological Conditions

3.0 EXISTING NOISE ENVIRONMENT

3.1 EXISTING SANTA MONICA MUNICIPAL AIRPORT NOISE

3.1.1 SANTA MONICA BACKGROUND

Santa Monica Municipal Airport serves as a general aviation airport. The use of Santa Monica Municipal Airport is heavily regulated as a result of its limited area and facilities, environmental sensitivity of the local area, and because of a long history of airport related litigation extending back at least to the 1960's. The operation of Santa Monica Municipal Airport is regulated by Federal, State, and local laws and regulations including the 2017 Consent Decree.

Santa Monica Municipal Airport has a long history of noise analyses and was one of the very early airports to install a permanent noise monitoring system. Extensive data from its noise monitoring system enables accurate modeling and prediction of noise levels. Both CNEL and SENEL are monitored and calculated for each day and each aircraft operated at the airport. CNEL data are collected at each of the six permanent noise monitoring sites. These sites are shown in [Exhibit 3-1](#).

The emphasis of the Santa Monica Municipal Airport noise abatement program is on regulating and limiting single event noise. This is in response to resident's concerns about high noise levels associated with some aircraft operations at the airport. Santa Monica is one of the very few airports that limit aircraft single event noise. Other airports that limit single event noise include John Wayne Airport, Long Beach Municipal Airport, Torrance Municipal Airport, and Hayward Air Terminal. Of these airports the noise limits vary and are difficult to compare because the location of the enforcement microphones at the various airports are not located in similar positions to the microphones at Santa Monica. Estimating the noise limits at all these airports using a common microphone location indicates that the John Wayne Airport and Long Beach Municipal Airport are much less stringent than Santa Monica (both include jet air carrier operations), Hayward Air Terminal is about 3 dB less stringent than Santa Monica and Torrance Municipal Airport noise limits are about the same as Santa Monica. No airport has limits more stringent than Santa Monica Municipal Airport.

3.1.2 EXISTING SANTA MONICA MUNICIPAL AIRPORT OPERATIONS DATA

Existing year 2018 aircraft operations at Santa Monica Municipal Airport totaled 72,061 of which some 2,971 are jet aircraft operations. These data were obtained from traffic counts kept by the FAA Air Traffic Control Tower and Santa Monica Airport staff. Note that an operation is defined as a takeoff or a landing. There were 3,658 helicopter operations. Therefore, 72,061 operations translate into 36,031 takeoffs and landings during the year. The total operations represent a decrease in operations from the year 2017 of approximately 8%. The jet operations represent a decrease of approximately 81% relative to the year 2017. Of the total operations, 49,440 were itinerant operations and 22,621 were local operations. "Local traffic" is defined as an aircraft that stayed within the Airport's Class D controlled airspace, generally within 5 nautical miles of the airport or within the airport traffic pattern. When counting local operations, the departure part of the touch and go is counted as one operation and the landing part is counted as another operation.

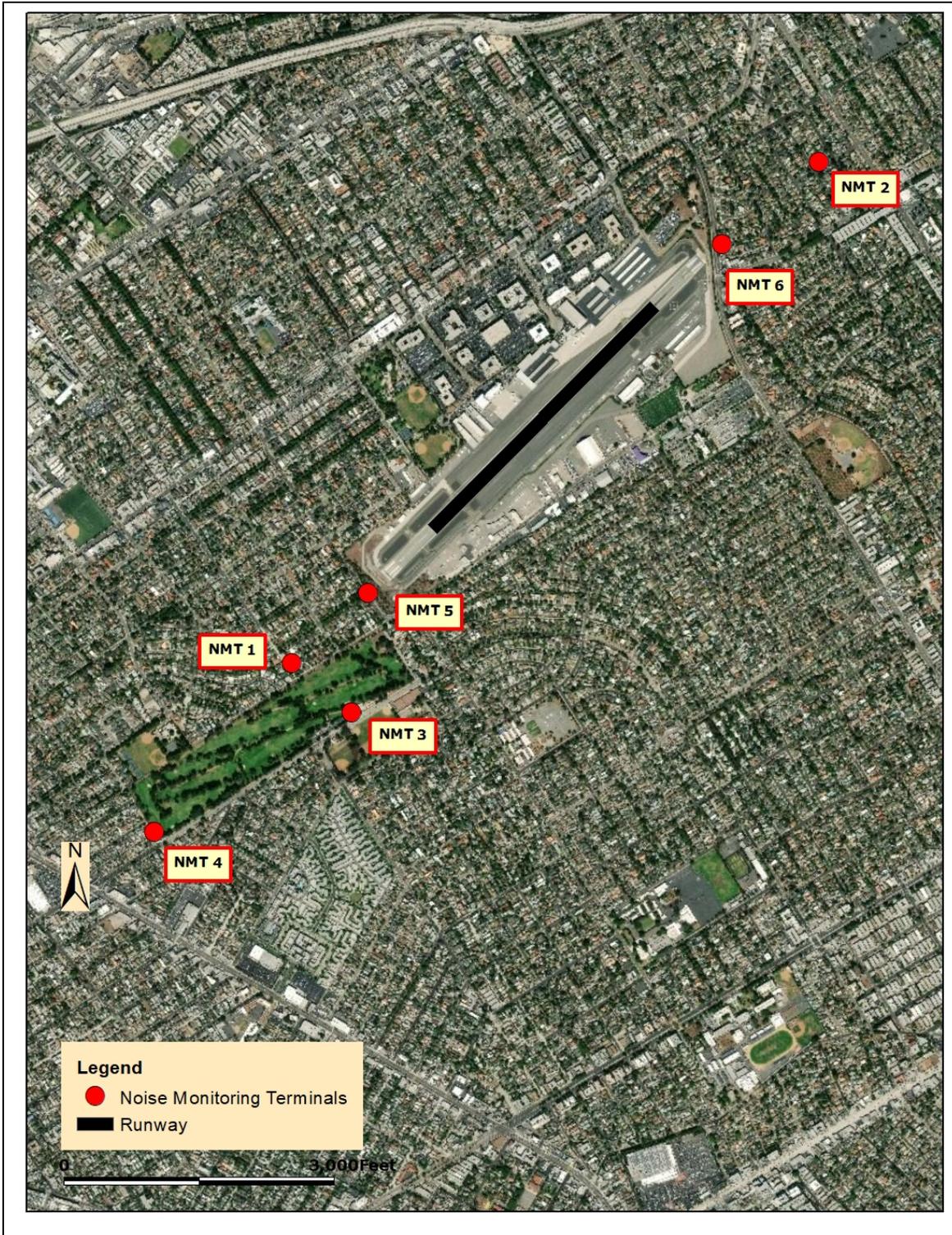


Exhibit 3-1
Noise Monitor Locations at Santa Monica Airport
Santa Monica Municipal Airport CNEL Contour Study

3.1.3 EXISTING SANTA MONICA MUNICIPAL AIRPORT FLEET MIX DATA

The type of aircraft using Santa Monica Municipal Airport were determined using the year 2018 flight information data from the airports noise monitoring system that is known as Airport Noise and Operations Monitoring System (ANOMS). All aircraft noise events for all of the year 2018 were downloaded and analyzed by aircraft type, operation, and runway used. Not all of the aircraft types that fly at Santa Monica are represented in the INM. The INM uses substitute aircraft to represent similar aircraft types. **Table 3-1** lists the jet aircraft types that were recorded at Santa Monica and the INM substitution used to model that aircraft.

**Table 3-1
Jet Aircraft Flown At Santa Monica and the INM Substitution**

Aircraft	INM substitution
C25A	CNA500
C25B	CNA500
C25C	CNA525C
C501	CNA500
C550	CNA55B
C560	CNA55U
C680	CIT3
E55P	CNA55B
FA50	GV
G280	CL600
H25B	LEAR35
LJ31	LEAR35
LJ35	LEAR35
LJ45	LEAR35
LJ55	LEAR35

Note: Aircraft names are shown using Santa Monica/Air Traffic Control 4 letter code and the INM Substitution name is the INM aircraft naming convention.

The annual operations data were then summarized by aircraft type using the INM aircraft types available. Single Engine propeller aircraft were divided into high performance singles (GASEPV) for aircraft such as the Bonanza, C210 and Cirrus 22 aircraft and low performance (GASEPF) for aircraft such as the C150 and C172. **Table 3-2** presents a summary of the annual operations by aircraft type used in the noise modeling. Note that the airport noise monitoring system does not record all flights and some flights are labeled as 'unknown' if the aircraft is flying under visual flight rules (VFR) and does not broadcast its identification. The single engine propeller aircraft operations were adjusted to increase these operations in order to replicate the total operations as reported by the FAA Tower in its annual operations report.

**Table 3-2
Summary of 2018 Annual Operations By Aircraft Type**

Itinerant:	INM Substitution	
	GASEPV	3,511
	GASEPF itinerant	35,448
	BEC58P	2,355
	CNA441	1,498
	CIT3	59
	CL600	116
	CNA500	585
	CNA55B	1,762
	CNA560U	184
	CNA525C	247
	LEAR35	12
	GV	6
	Helicopter	3,658
Local:		
	GASEPF	22,621
Total:		72,061

3.1.4 SANTA MONICA MUNICIPAL AIRPORT RUNWAY AND FLIGHT TRACK UTILIZATION

The flight tracks at Santa Monica Municipal Airport are well established to take advantage of the runway configuration and prevailing wind conditions. Runway 3/21 is 3,500 feet long and is the only runway at the airport. With winds predominantly coming from the ocean, aircraft typically depart to the west and arrive from the east on Runway 21. Only during Santa Ana wind conditions or other winds that move toward the ocean does the flow reverse with departures to the east and arrivals from the west. East flow occurred approximately 3.5 percent of the time in 2018.

Departures to the west are grouped into two major tracks. Small aircraft doing visual departures follow a track that proceeds over the golf course and pilots are instructed to not turn prior to Lincoln Boulevard to the south and the shoreline to the north. Larger aircraft doing instrument departures proceed straight along the extended runway centerline. All twins, turboprops, and business jets were modeled on the straight out departure. These aircraft are generally doing an Instrument Flight Rules (IFR) departure and are instructed to fly runway heading departures. Arrivals are from the east and are on a straight in track by the time they get within the airport environs. The local pattern is a left hand pattern. Helicopter departures use the runway heading departure similar to fixed wing aircraft and helicopter arrivals are from the north and south of the airport. INM flight tracks are shown on [Exhibit 3-2](#) and a sample of radar flight tracks are shown in the attachment. The tracks were refined using radar data collected from the airport's noise monitoring system. Sample radar tracks are attached to this report. When winds dictate flow to the east, the aircraft are assumed to operate on straight in and straight out flight tracks.

The day/evening/night distribution of operations was derived from noise monitoring system data for the year 2018. The data logs show 92.6 percent of the operations during daytime hours (7 am to 7 pm), 6.4 percent during the evening hours (7 pm to 10 pm), and 1.0 percent of the operations during the night hours (10 pm to 7 am).

3.1.5 SANTA MONICA MUNICIPAL AIRPORT NOISE MONITORING DATA

The remote monitoring sites were shown in [Exhibit 3-1](#). The CNEL measured at each of these sites during calendar year 2018 are shown in [Table 3-3](#).

**Table 3-3
CNEL Measured During Calendar Year 2018**

Site	2018 CNEL, dB
1	56.2
2	52.5
3	54.7
4	54.2
5	58.3
6	59.0

The noise monitoring system data were reviewed by aircraft type to determine the single event noise levels associated with each aircraft type. This was done using 2018 operations and noise data in order to develop aircraft flight profiles needed to use in the INM in order to get noise model results to match noise measurement results. Because of the strict noise limits at Santa Monica Airport, aircraft generally use procedures that are not represented by the typical aircraft flight procedures that are contained in the INM. **Exhibit 3-3** shows the results of the SENEL analysis by aircraft type for noise measurements made at site NMT 1 for aircraft departures and site NMT 2 for aircraft arrivals. Note that the quantity shown is the energy average SENEL. Energy average is a form of averaging used for logarithmic data such as decibels. The energy average is biased towards the higher values in the distribution. For example, the more typical arithmetic average of the two numbers 50 and 100 is a value of 75. But the energy average of the decibel values 50 and 100 results in an energy average of 97 decibels. Note also that in computing the averages, the number used for the sample size was the actual number of measured noise events plus the number of noise flights that were tracked but did not generate a noise event. For the flights that did not generate a noise event and assumed SENEL was included that was based on the loudest an aircraft could be without triggering a noise event in the noise monitoring system. Note also that aircraft types shown in **Exhibit 3-3** represent the aircraft indicated plus all the aircraft for which this aircraft was the INM substitute. For example, the noise level for the aircraft shown as the CNA55B included the C550, E50P, and the E55P aircraft.

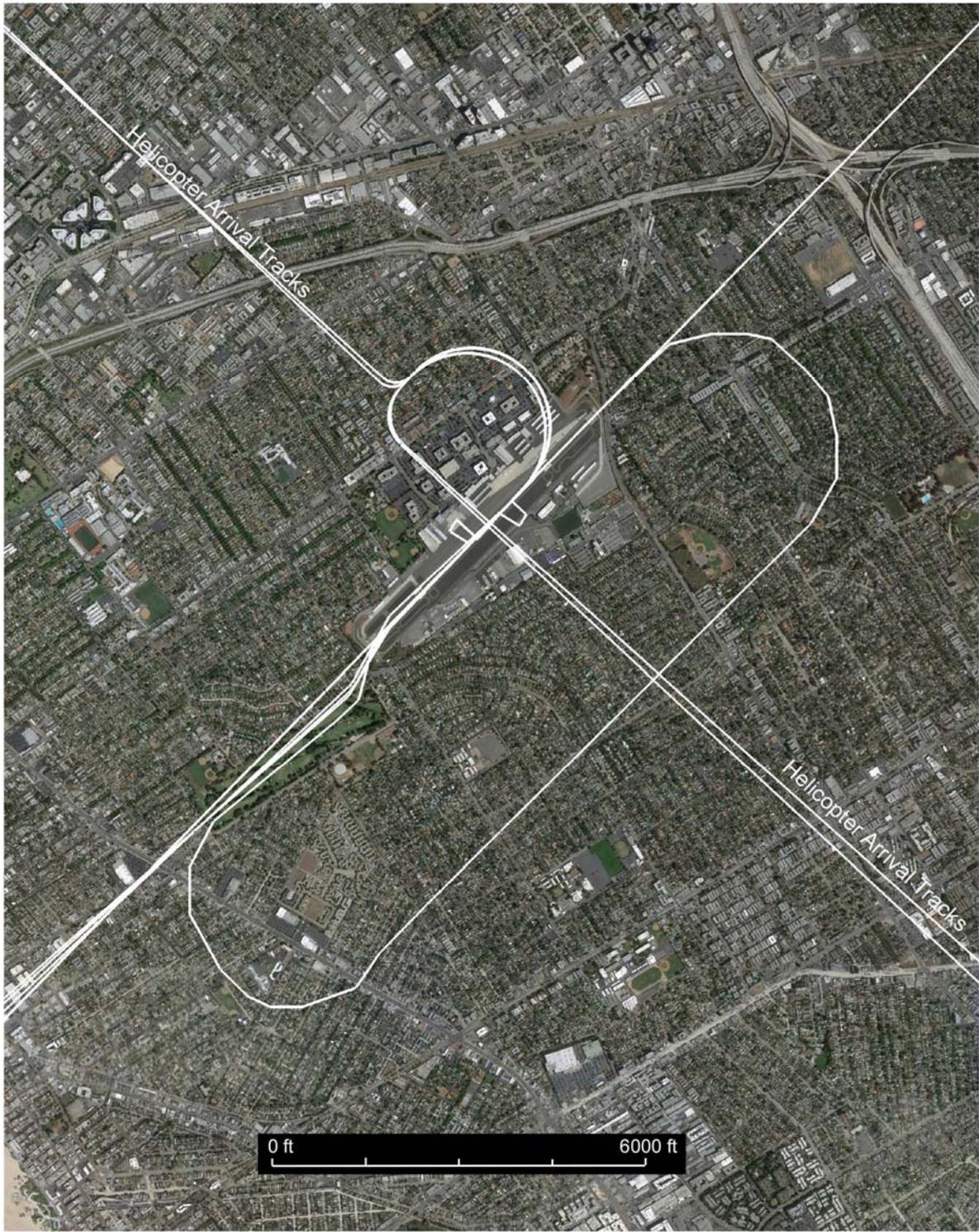


Exhibit 3-2
Flight Tracks Used For INM Modeling
Santa Monica Municipal Airport CNEL Contour Study

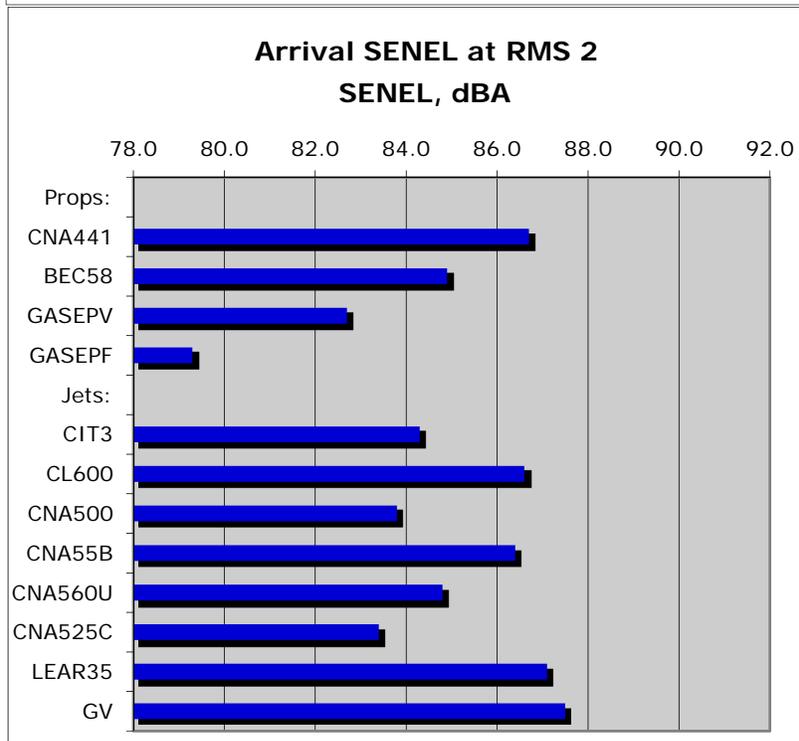
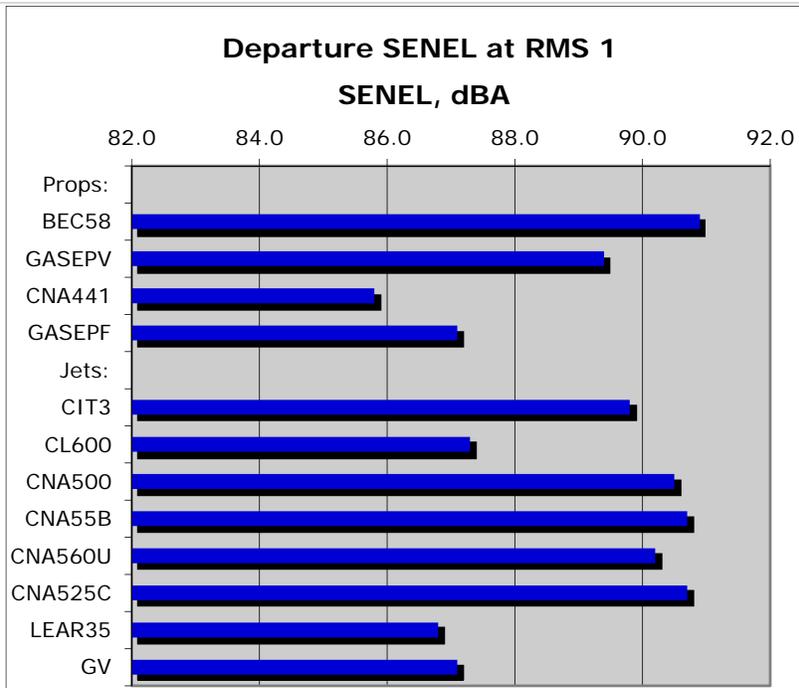


Exhibit 3-3
Energy Average SENEL By Aircraft Type
Santa Monica Municipal Airport CNEL Contour Study

3.1.6 SANTA MONICA MUNICIPAL AIRPORT YEAR 2018 CNEL CONTOURS

The CNEL contours used to depict existing noise exposure at Santa Monica Municipal Airport were developed using the INM Version 7.0d. The 60, 65 and 70 dB CNEL contours are depicted on Exhibit 3-4. Table 3-4 compares the measured CNEL with the CNEL predicted by the INM model at the 6 measurement sites.

**Table 3-4
Comparison of 2018 Measured CNEL with Modeled CNEL**

Site	Measured CNEL	Modeled CNEL
1	56.2	56.0
2	52.5	52.5
3	54.7	54.7
4	54.2	54.2
5	58.3	58.3
6	59.0	57.7

The comparison of measured versus modeled results is very good for sites 1, 2, 3, 4, and 5. For Site 6, the measured noise level was lower than the modeled noise level, which is likely due to aircraft noise events and community noise events occurring simultaneously.

Some caution is warranted when reviewing the noise contours. The noise contours at the east end of the airport are shaped by 2 types of operations, arrivals to Runway 21 and noise aft of the aircraft generated during departure on Runway 21. The noise generated aft of the aircraft during pre-takeoff engine run and takeoff roll is modeled in the INM using a generic aircraft directional pattern that may or may not be representative of the aircraft that operate at Santa Monica Municipal Airport.

Historically, jet aircraft have produced the dominating sound exposure contribution to the CNEL contours. However, due to the shortening in length of Runway 3/21, an 81 percent reduction in jet aircraft operations as reduced their sound exposure contribution. As the number of jet aircraft operations at the airport decreased, the dominant aircraft type at Santa Monica relative to CNEL became the single-engine propeller aircraft.



Exhibit 3-4
Year 2018 CNEL Contours Santa Monica Airport
Santa Monica Municipal Airport CNEL Contour Study

4.0 HISTORICAL NOISE MONITORING DATA

4.1 HISTORY OF CNEL MEASUREMENT DATA, 1988 TO 2018

The original noise monitoring system was installed in the 1970's and replaced in 1988, and 2017. The historical CNEL data from the existing system are plotted in [Exhibit 4-1](#). Note that the apparent increase in noise level in 2011 is due to both an increase in jet and propeller operations from the year 2010 to 2011 as well as retuning of the noise event filter in the noise monitoring system. Since 2012, the noise levels have stabilized or decreased as a result of reduced operations. Note the decrease in CNEL in 2018 due to a decrease in jet aircraft operations.

CNEL measurements recorded prior to 1988 are available and were reported occasionally. Data for the years 1982, 1983, 1985 and 1987 were found for Site 1. These are listed in [Table 4-1](#).

Table 4-1
Pre-1988 CNEL Measurement Data for Site 1

Year	CNEL
1982	62.1
1983	61.5
1985	58.8
1987	57.9

5.0 REFERENCES

1. U.S. Department of Transportation, Federal Aviation Administration, "Integrated Noise Model (INM) Version 7.0 User's Guide," April, 2007.

SMO CNEL History 1989 - 2018

[Note: Measurement system returned in 2011 to capture more noise events.]

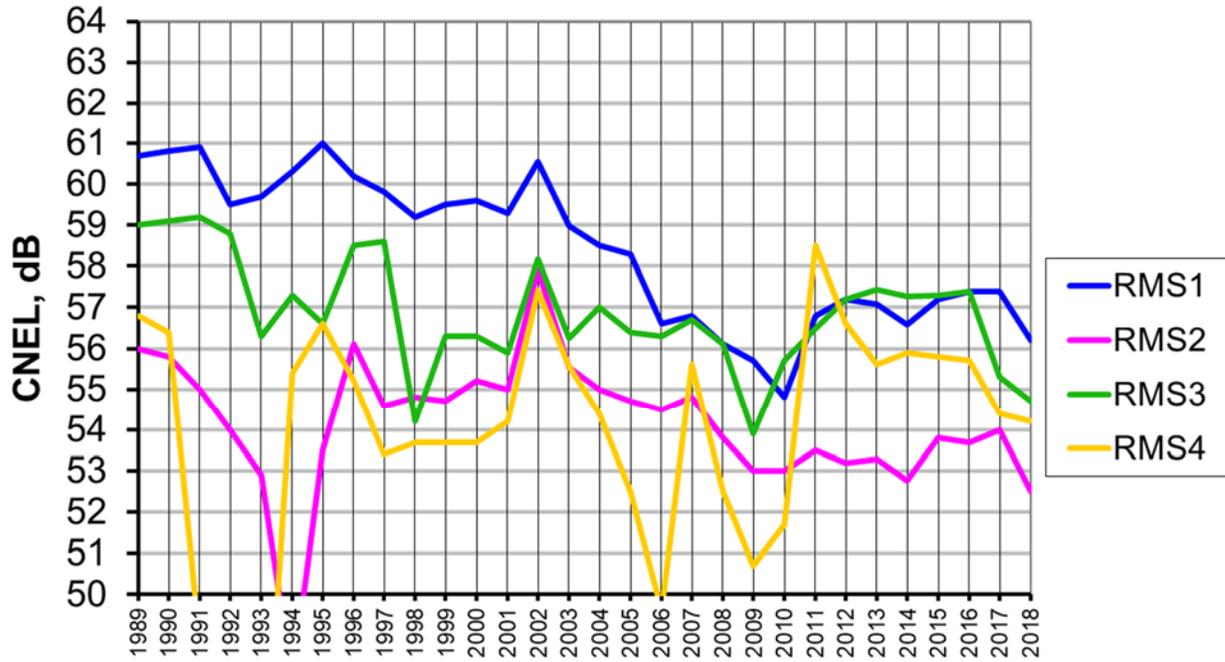


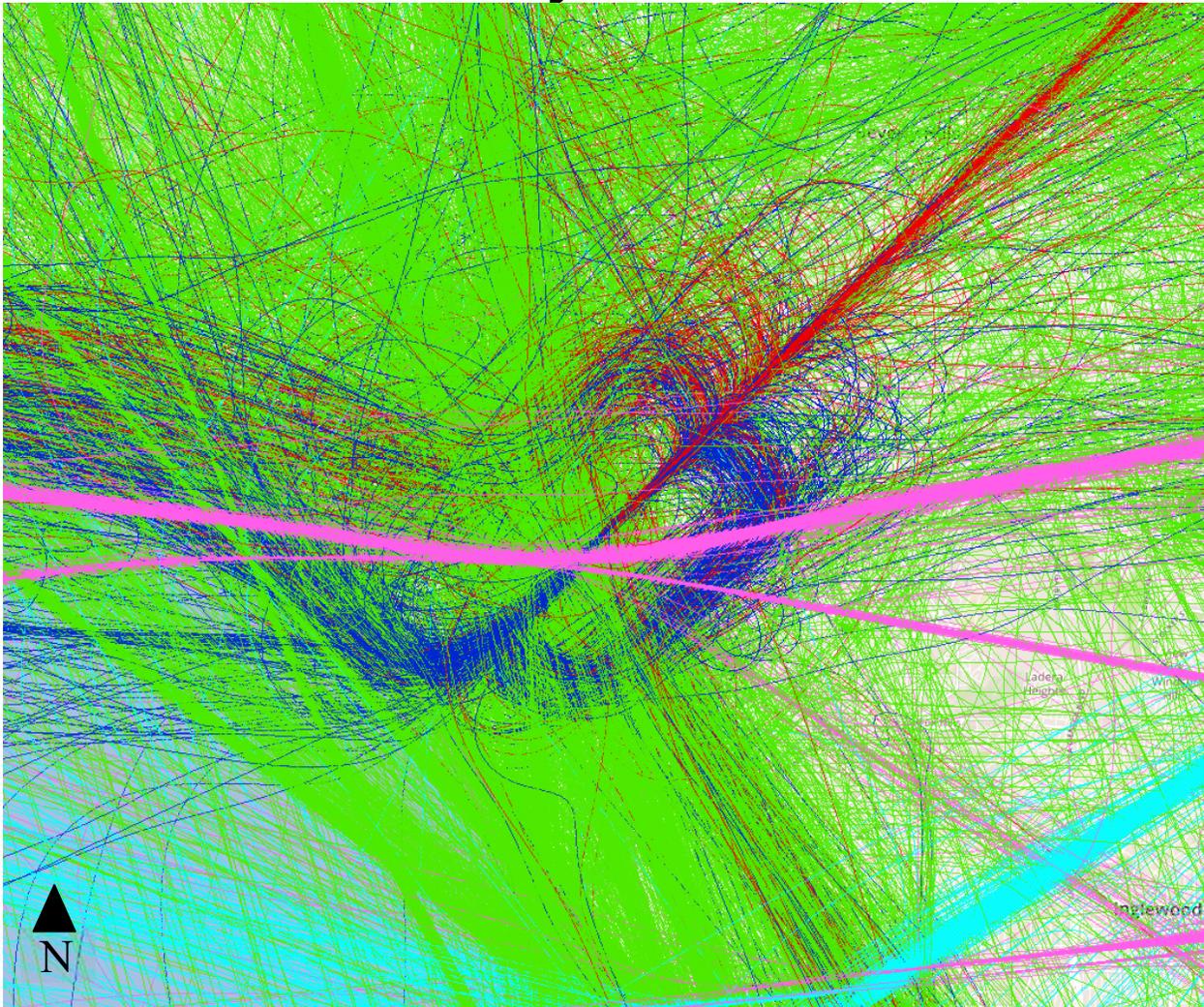
Exhibit 4-1

History of CNEL, Sites 1 – 4, 1989 - 2018

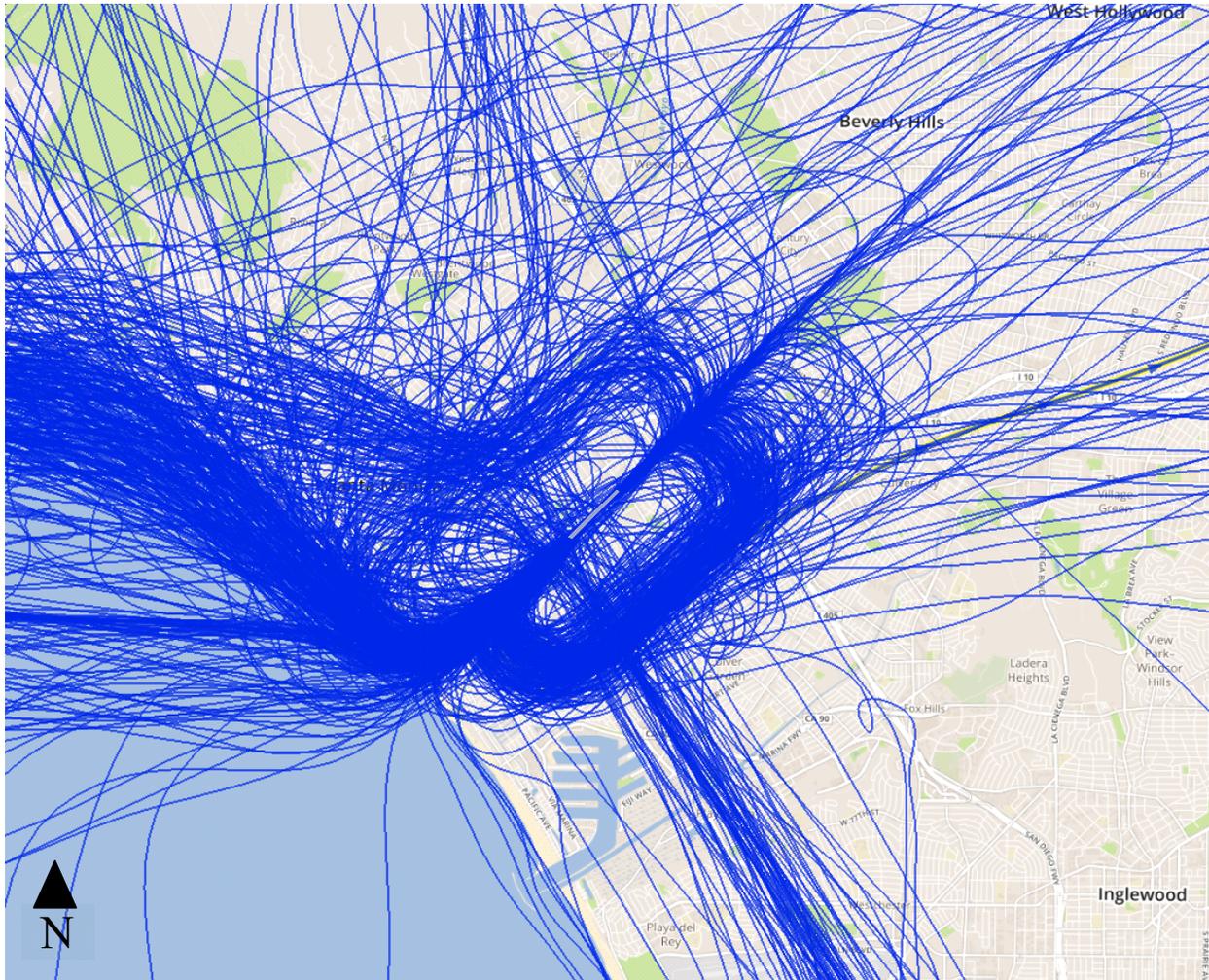
Santa Monica Municipal Airport CNEL Contour Study

Attachment

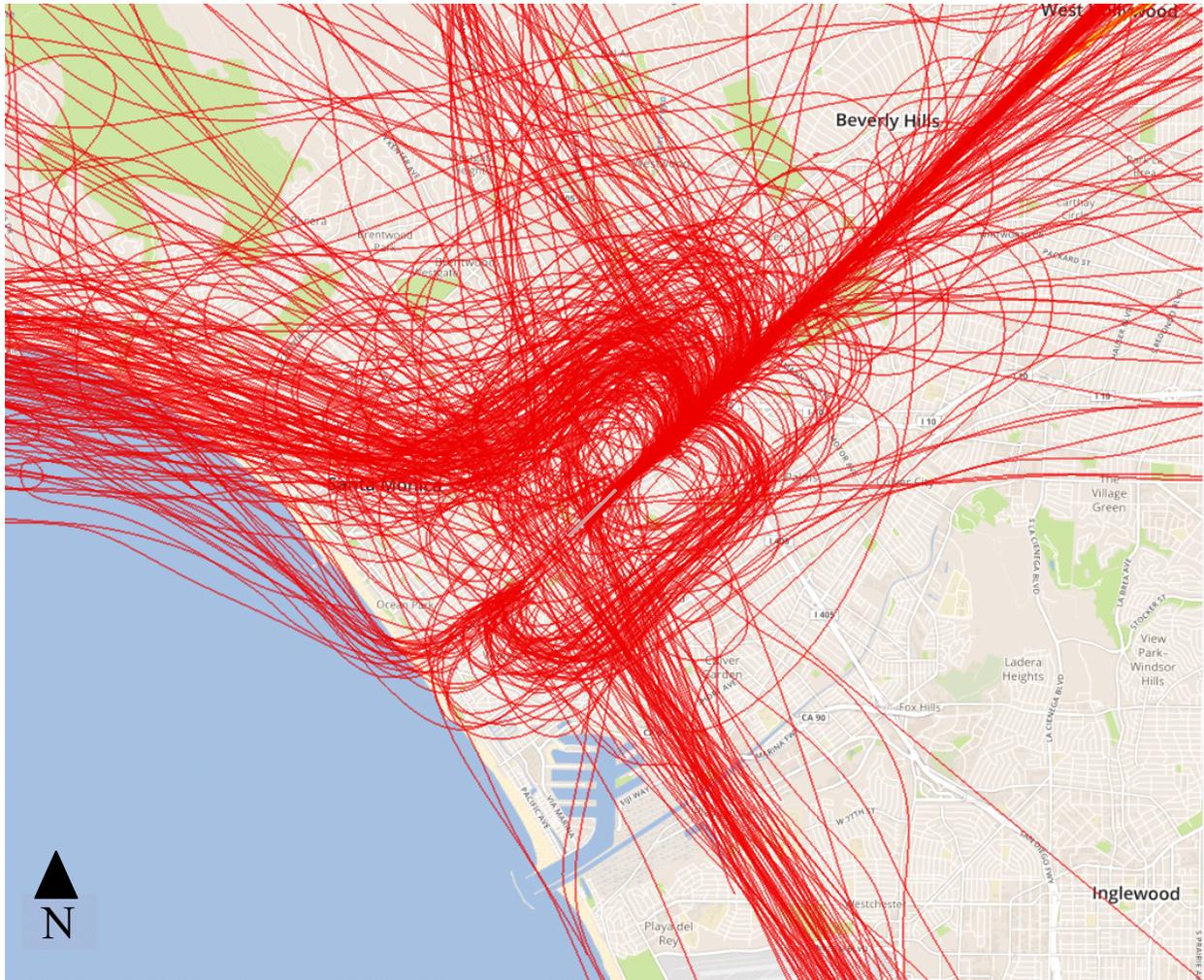
Sample Radar Tracks From Noise Monitoring System



August 1-7, 2018 All Operations Including Overflights From Other Airports



August 1-7, 2018 All SMO Departures



August 1-7, 2018 All SMO Arrivals